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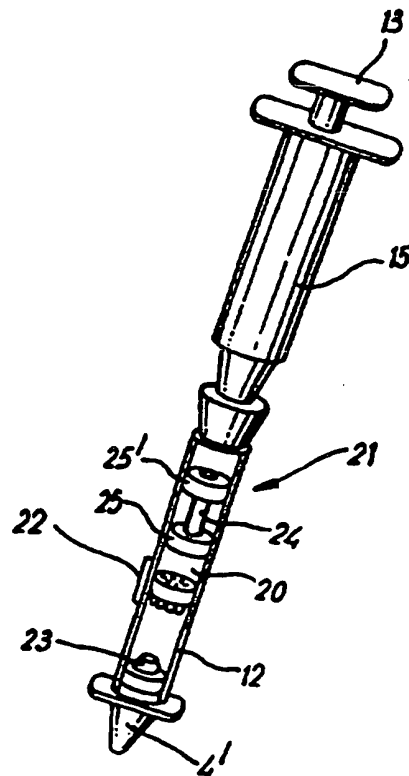
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(54) Title: FLUID SAMPLING DEVICE

## (57) Abstract

There is described a device for sampling fluids, and in particular a device which can obtain a sample of body fluid such as blood, filter the sample, and perform an assay on the filtrate to detect the presence of a particular component therein. The device has filtration means (22) for separating components of the fluid, a conduit directing flow of the fluid to be sampled from a source through the device, and sensing means (21) which can detect the presence of a component in the fluid. Optionally the device has a puncture means (5), such as a hypodermic needle for puncturing the skin to access the fluid. The conduit may be a hollow fibre membrane which then also acts as the filtration means. Preferably the sensing means is also presented on a membrane surface.



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1     "FLUID SAMPLING DEVICE"

2  
3     This invention relates to a device for sampling fluids,  
4     and in particular concerns a device which can obtain a  
5     sample of a fluid (such as blood), filter the sample,  
6     and perform an assay on the filtrate to detect the  
7     presence of a particular component therein, such as a  
8     pathogen.  
9

10    Conventional blood-sampling devices are not known to  
11    comprise filter means for separating the blood  
12    components before testing. Thus, to be tested for the  
13    presence of viral proteins, the blood must first be  
14    extracted from the patient, separated into serum and  
15    cells, for example by centrifugation, and the serum  
16    assayed in a separate vessel. This can be time  
17    consuming and can therefore add to the costs involved  
18    in a diagnostic testing procedure.  
19

20    In addition, current blood sampling devices generally  
21    comprise puncturing means which pierce the skin of a  
22    patient and extract a relatively high volume of blood  
23    from the patient, for example a needle and syringe

1 arrangement whereby the needle pierces the skin and  
2 enters a blood vessel and blood is extracted from the  
3 patient into the syringe body. This can be traumatic  
4 for the patient and an unnecessarily high volume of  
5 blood can be taken, most of which is not required for  
6 sampling.

7  
8 The present invention provides a device for sampling a  
9 fluid, the device having filtration means for  
10 separating components of the fluid, a conduit directing  
11 flow of the fluid to be sampled from a source through  
12 the device, and sensing means which can detect the  
13 presence of a component in the fluid.

14  
15 The relatively small size of the device ensures it's  
16 portability and the device will normally be shaped and  
17 dimensioned so to be convenient to hand-hold. The  
18 device will normally be a single-use disposable item.

19  
20 In certain embodiments the device has puncture means  
21 such as a hypodermic needle to pierce the skin of a  
22 patient and allow the sampling of blood, synovial fluid  
23 or other body fluids therefrom. Biopsy needles or  
24 small bore needles may be used as a puncture means in  
25 the device. Fluid may also be extracted directly from  
26 tissue by exerting pressure on the tissue; this  
27 extraction may occur in situ or using a sample excised  
28 from the patient's body.

29  
30 Alternatively, the fluid may be sampled non-invasively  
31 and thus a puncture means may be unnecessary. For  
32 example the fluid may be tears, urine or saliva, all of  
33 which can be sampled non-invasively. Thus the device  
34 may have a nozzle or other means to enable access into  
35 areas of restricted access.

36

1 Where present, the puncture means is desirably hollow  
2 and may be linked to the conduit.

3  
4 The conduit can simply comprise the filtration means in  
5 the form of a hollow membrane fibre through which the  
6 body fluid can flow, or a bundle of such fibres. The  
7 device may also have a chamber for collecting the  
8 filtrate. The chamber may also contain the sensing  
9 means.

10  
11 The fluid may comprise a liquid or a gas. In one  
12 embodiment the fluid may be a physiological sample such  
13 as blood, synovial fluid, tissue fluid, urine, tears,  
14 saliva etc. The fluid may also consist of a tissue  
15 sample, dissolved or suspended in a liquid medium.

16  
17 However, the device may also be applied in non-medical  
18 or non-veterinary applications. For example the device  
19 may be used to sample fluids such as river water,  
20 sewage, industrial fluids or effluent, foodstuffs (for  
21 example milk, cheese, yogurt, beer, meat or fish).

22  
23 Filtration of the sample preferably access through  
24 cross-flow filtration.

25  
26 The filtration means may be woven or non-woven and can  
27 optionally comprise a membrane filter having pore sizes  
28 selected to separate, for example, blood cells from  
29 other blood components. The filtration means can be  
30 selected to filter out a particular molecule size range  
31 so that only a particular size range of molecule is  
32 present in the filtrate.

33  
34 In one embodiment of the invention, the filtration  
35 means comprises a membrane filter in the form of a  
36 hollow membrane fibre or a bundle of such fibres

1 through which the body fluid flows, so that filtration  
2 of the fluid occurs by cross-filtration, i.e., by flow  
3 of fluid along the surface of the filtration means,  
4 rather than perpendicularly towards the filtration  
5 means. The filtration means can also comprise a sheet  
6 of membrane filter which extends either transversely  
7 across or longitudinally along the lumen of the conduit  
8 or chamber, and preferably separates the needle from  
9 the sensing means.

10

11 The filtration means for use in the apparatus of the  
12 invention may be of any convenient shape and mention  
13 may be made of hollow membrane fibres and flat sheet  
14 membranes. Hollow membrane fibres or bundles of such  
15 fibres may be preferred in certain situations since  
16 this form permits a relatively large surface area  
17 through which filtration may occur. For other  
18 applications, however, flat membrane sheets (or layers  
19 of such sheets) may be preferable.

20

21 The filtration means may be made of any convenient  
22 material and the present invention is not limited with  
23 regard to the filtration means to be used. Generally  
24 the filtration means will be selected for the pore size  
25 of the filter. Ceramic filters, for example, may  
26 filter particles of diameter  $5.0\text{ }\mu\text{m}$  to  $0.1\text{ }\mu\text{m}$  and hollow  
27 fibre membranes may filter molecules of 1 mDa to 5 kDa.  
28 Suitable membranes are available commercially and may  
29 be made of polysulphone, cellulose, cellulose  
30 diacetate, polypropylene and/or ceramics materials.

31

32 In one embodiment the filtration means is in the form  
33 of a membrane embedded in a holding means located  
34 within the device. For example, hollow fibre  
35 membranes, bent into a "U" shape, may be embedded in a  
36 holder, for example a plug formed from cured adhesive.

1 The plug forms a close fit with the internal walls of a  
2 conduit within the filtration device. Reference may be  
3 made to the co-pending PCT Patent Application in the  
4 name of FSM Technologies Ltd filed 5 December 1995,  
5 claiming priority from GB9424703.8, (incorporated  
6 herein by reference) as describing suitable membrane  
7 filtration means.

8  
9 This embodiment allows the use of a membrane having a  
10 greater filtration surface area than the cross-  
11 sectional filtration area of the conduit. Generally  
12 the membrane in the filtration means is essentially  
13 three-dimensional. The membrane may have any  
14 convenient shape or configuration.

15  
16 The term "cross-sectional filtration area" refers to  
17 the area of a cross-section of the conduit over which  
18 filtration occurs. Normally this would be the area of  
19 the lumen of the conduit. It may be possible to locate  
20 the filtration means part way along the length of the  
21 lumen. If the walls of the conduit are sloping (and  
22 therefore the cross-sectional area of the conduit  
23 varies) the "cross-sectional filtration area" is the  
24 cross-sectional area of the conduit at the point where  
25 the filtration means is located.

26  
27 It is important that part of the membrane of the  
28 filtration means communicates with the exterior sides  
29 of the holder so that the sample entering the device  
30 (optionally under pressure) can be separated, the  
31 filtrate optionally being collected in a collection  
32 chamber.

33  
34 In more detail the filtration means of the present  
35 invention may be formed from hollow fibre membranes  
36 which are wound round to form a spiral which is held in

1 a holder. The spiral may be either two dimensional,  
2 that is forms a flat coil, or may be three-dimensional  
3 in which case the spiral is wound upwardly into a apex.  
4

5 Alternatively the filter may be formed from "U"-shaped  
6 hoops of hollow membrane fibres. Preferably several  
7 hoops, for example over 10 hoops, especially 20 to 50  
8 hoops, are present in each filtration means. The ends  
9 of each hoop pass through and are held by the holder.  
10

11 The filter may be formed into hoops as described above,  
12 but the upper portion of the hoops are bent into an  
13 acute angle, thus forming an inverted "V" shape. The  
14 angle may conveniently be introduced into the membrane  
15 by spot application of heat which welds the sides of  
16 the membrane together at the point where heat is  
17 applied, thus forming a hinge.  
18

19 In another embodiment, hollow fibre membranes each  
20 having a "blind" or closed end may be used. In one  
21 arrangement the blind ends may be exposed to the  
22 sample. For example, multiple short lengths of hollow  
23 fibres may be used, the blind end of each fibre being  
24 exposed to the sample whilst the open ends are held by  
25 the holder (eg are potted into the plug) and  
26 communicate with the filtrate chamber. Conveniently  
27 the blind ended fibres diverge away from a central  
28 portion of the holder.  
29

30 In an alternative embodiment using blind ended hollow  
31 fibre membranes, short lengths of the fibres are cut  
32 and joined together at the apex (thus closing their  
33 lumens at that point) into a "teepee"-like shape. The  
34 apex is exposed to the sample whilst the opposite ends  
35 of the membrane fibres pass through the holder and are  
36 exposed on the opposite side thereof.

1 The filtration means in this embodiment is located  
2 within the device by means of the holder which will  
3 normally be a plug of cured adhesive. The plug forms a  
4 tight fit with the inside surfaces of the conduit  
5 lumen. It is essential that the plug or any other  
6 holder seals the conduit lumen, as the sample to be  
7 filtered could otherwise pass through the gap between  
8 the plug and the interior of the conduit. The filter  
9 itself is at least partially embedded within the plug.

10  
11 The plug will normally be formed from adhesive, usually  
12 cured adhesive. Any material capable of forming a seal  
13 with the membrane fibres and the filter chamber may be  
14 used.

15  
16 The adhesive used to form the filter plug of the  
17 present invention may be any adhesive material which  
18 does not react with the membrane or filter chamber  
19 materials in a deleterious manner. Preferably the  
20 adhesive material is quick setting, ie cures within  
21 minutes, for example under 5 minutes. For certain  
22 embodiments adhesive material which cures upon exposure  
23 to light is particularly desirable. For example in  
24 medical applications it may be preferred to use  
25 adhesive which cures upon exposure to blue light,  
26 especially UV light.

27  
28 Suitable adhesive material is commercially available  
29 and mention may be made of polymers available from  
30 Ablestick Ltd (for example LCM 32, LCM 34 and LCM 35),  
31 Bostick Ltd or Dynax Inc (eg 191M) as being suitable UV  
32 curing adhesives.

33  
34 The sensing means can comprise chemical agents such as  
35 catalysts, pH indicators, or molecules such as DNA,  
36 lectins, antibodies or abzymes (reactive against viral

1 proteins, for example) or enzymes. Alternatively, the  
2 sensing means may be electronic, such as a device known  
3 as an "electronic nose" which detects the presence  
4 and/or concentration of a gas. Optionally, the sensing  
5 means can comprise two or more of such devices and/or  
6 chemicals/molecules which may act sequentially or  
7 together on the same filtered sample.  
8

9 The sensing means may be localised on a membrane  
10 located within the device, usually so that the filtered  
11 sample is exposed thereto. In one embodiment a potted  
12 membrane (as described above for the filtration means)  
13 is provided, the membrane being treated to allow  
14 detection of a specific component that may be present  
15 in the sample. Suitable examples are given in co-  
16 pending PCT Patent Application No PCT/GB95/01834, the  
17 disclosures of which are hereby incorporated by  
18 reference.  
19

20 Alternatively, the sensing means may be disposed on or  
21 in the filtration means, for example, in the case of a  
22 chemical or molecular sensing means, it can be bonded  
23 to one side of the filter, such as by covalent or ionic  
24 bonding, or by hydrophobic or hydrophilic attraction to  
25 the filtration means or can be impregnated therein. It  
26 may be desirable for a chemical or molecular sensing  
27 means to be attached to the filtration means by  
28 covalent bonding, optionally via a spacer molecule, so  
29 that the presentation of the sensing means is enhanced,  
30 and/or that steric interference is reduced or avoided.  
31

32 Optionally, the sensing means can be provided in the  
33 chamber, and can be presented on the chamber walls, or  
34 on beads, rods or the like located within the chamber.  
35

36 The sensing means can react with a component in the

1 filtered sample so as to effect a colour change in the  
2 sensing means or in a substrate optionally present.  
3 Thus, the presence/concentration of the component  
4 detected can be observed visually or  
5 spectrophotometrically. In such an embodiment, the  
6 device or the chamber may desirably be partially or  
7 wholly constructed from transparent or translucent  
8 material, such as moulded plastics material.

9  
10 Preferably, the puncture means comprises a needle, most  
11 preferably of very narrow bore.

12  
13 Embodiments of the device can provide a self contained  
14 sampling and assay system, and can function effectively  
15 with low volumes of fluid so as to avoid the need to  
16 extract large volumes of the fluid.

17  
18 The fluids to be sampled may flow into the device  
19 through surface tension or capillary action without any  
20 other force required to draw the body fluids towards  
21 the filtration means. However, the device may be used  
22 in conjunction with pressure means such as a  
23 conventional syringe in order to produce a pressure  
24 differential across the filtration means, for example  
25 by providing a suction pressure to draw the body fluids  
26 through the conduit into the device and/or across the  
27 filtration means. Once the fluid has entered the  
28 device, the pressurizing means may also be used to  
29 induce pressure in the fluid to be filtered thereby  
30 speeding up the rate of filtration. The device may  
31 also incorporate sealing means to seal the fluid in the  
32 device when the fluid is being pressurized, so that  
33 more efficient filtration through the membrane is  
34 achieved. Advantageously, the sealing means may  
35 comprise a cap for the device or a portion of such a  
36 cap.

1 An embodiment of the present invention will now be  
2 described by way of example, with reference to the  
3 accompanying drawings, in which;

4  
5 Fig. 1 is a side view of a device according to the  
6 invention;

7 Fig. 2 shows a detailed view of the device shown  
8 in Fig. 1;

9 Fig. 3 shows the device in use drawing fluid into  
10 the device;

11 Fig. 4 shows the device in use expelling fluid  
12 from the syringe;

13 Fig. 5 shows a close up view of the device in use  
14 drawing blood from a blood vessel into the device;

15

16 Fig. 6 shows a close up view of the device showing  
17 the fluid being forced through the filtration  
18 means;

19 Fig. 7 shows a cross-section an alternative device  
20 according to the invention;

21 Fig. 8 shows a perspective cross-sectional view of  
22 the device of Fig. 7; and

23 Fig. 9 illustrates optional attachments adapted to  
24 fit onto the device of Figs. 7 and 8.

25

26 Referring now to the drawings, a device 1 according to  
27 the invention comprises a needle 5 covered by a cap 6.  
28 The needle 5 is hollow and its bore communicates with  
29 the bore of a hollow membrane fibre 10 enclosed in a  
30 housing 12 which provides support to the relatively  
31 fragile membrane fibre 10. The hollow membrane fibre  
32 10 is in the form of a hollow tube of exemplary  
33 diameter 0.5mm formed from a membrane filter which can  
34 filter out molecules of 1000kDa. One end of the fibre  
35 10 is connected to the needle 5, and the other end of  
36 the fibre 10 is connected to a conventional syringe 15.

1 The housing 12 comprises a hollow tube of clear  
2 plastics material of internal diameter 1mm, and  
3 optionally has a generally cuboidal collecting chamber  
4 20 of the same material attached to one side of the  
5 housing 12.

6  
7 The collecting chamber 20 contains glass or plastics  
8 beads (not shown) which have sensing means (in this  
9 case anti-viral antibodies) attached thereto,  
10 optionally by covalent bonding. The choice of sensing  
11 means can vary widely according to the component to be  
12 detected.

13  
14 In use, the device 1 is uncapped and the needle 5 is  
15 inserted into a patient's thumb (see Fig. 3) or another  
16 part of the patient's body, so as to pierce a blood  
17 vessel (see Fig. 5). The blood may be allowed to flow  
18 through the needle 5 and hollow membrane fibre 10 by  
19 capillary action or can be drawn into the device by  
20 pulling the plunger 13 of the syringe 15 in the  
21 direction of arrow 16 (see Fig. 3), so that blood 11 is  
22 collected in the hollow membrane fibre 10. The hollow  
23 membrane fibre 10 can have a very narrow bore so that  
24 the volume of blood 11 required to fill it can be less  
25 than 0.1  $\mu$ l.

26  
27 Once a sufficient quantity of blood 11 is collected in  
28 the fibre 10, the plunger 13 of the syringe may be  
29 depressed in the direction of arrow 17, pressurizing  
30 the blood 11 and forcing it through the membrane of the  
31 fibre 10.

32  
33 The cap 6 can be replaced during this step thereby  
34 sealing the bore of the needle 5 at 7 and forcing the  
35 blood 11 to pass through the membrane, but replacement  
36 of the cap is not necessary. Sufficient pressure can

1 be obtained by depressing the syringe plunger without  
2 sealing the bore. Indeed, pressurizing the blood 11 is  
3 actually unnecessary since the device can simply be  
4 shaken to facilitate filtration.

5  
6 The blood cells and other blood components too large to  
7 pass through the pores of the membrane are retained  
8 within the fibre 10 and the serum containing the  
9 filtered components 14 is collected in the collecting  
10 chamber 20 where it mixes with the glass or plastic  
11 beads to which the sensing means are attached. The  
12 walls (or a portion thereof) of the chamber 20 can be  
13 transparent, and a positive indication of the presence  
14 of particular components can be visualised directly by  
15 observing eg colour changes in a reagent optionally  
16 also present in the chamber. The concentration of the  
17 components can be measured by spectrophotometric  
18 analysis using conventional methods.

19  
20 A bulbous head 6a in the cap 6 can be used to contain  
21 any fluids passing through the needle bore during the  
22 pressurization step.

23  
24 Modifications and improvements may be incorporated  
25 without departing from the scope of the invention.  
26 For example, the inner walls of the housing 12 can be  
27 inclined from the chamber 20 so that all drops of  
28 filtrate coming through the membrane are more  
29 efficiently collected in the chamber 20. Alternatively  
30 the chamber 20 may be disposed at one end of the  
31 device, so that it can be shaken by hand to encourage  
32 movement of drops of filtrate towards the chamber 20.

33  
34 Referring to Figure 7, this shows a cross section of an  
35 alternative embodiment of a device 1 according to the  
36 present invention. Device 1 comprises housing 12

1 having located therein a filtration means 22 which in  
2 this embodiment comprises a hollow fibre membrane  
3 shaped into a "U" or hoop the ends of the fibre being  
4 embedded within in a solid plug of cured adhesive so  
5 that the lumen of the ends are exposed on the opposite  
6 side of the plug to the main body of the "U" or hoop.  
7 In use the sample enters device 1 via aperture 2, is  
8 taken up into housing 12 and exposed to filtration  
9 means 22. The fluid sample may be urged across the  
10 filtration means 22 by application of pressure, for  
11 example by fitting a conventional syringe 15 to device  
12 1 as depicted in Figure 7 and urging plunger 13 of  
13 syringe 15 in the direction of arrow 16. The filtrate  
14 cross the hollow fibre membrane, collects in the lumen  
15 thereof and passes into collection chamber 20 by  
16 running down the lumen to the open ends thereof which  
17 are exposed on the opposite side of the plug to the  
18 main body of the hoop, facing the collection chamber  
19 20. Collection chamber 20 in this embodiment is that  
20 part of housing 12 located above the filtration means  
21 22. The portion of the sample not able to pass through  
22 the hollow fibre membrane cannot pass into the  
23 collection chamber 20.

24  
25 The filtrate then comes into contact with sensing means  
26 21. As shown in Figure 7 sensing means 21 comprises  
27 treated hollow fibre membrane 24, the ends of which  
28 pass through plugs 25 and 25'. Thus, the filtrate is  
29 taken into the internal lumen of hollow fibre 24, which  
30 has been treated with an agent able to detect a  
31 component believed to be present within the sample.  
32 The presence of that component results in a colour  
33 change which is directly visualised through the device,  
34 for example exposing the device to UV light.

35  
36 Optionally the device 1 depicted in Figure 7 may

1 comprise a puncture means 5 which in the device as  
2 illustrated consists of a hypodermic needle having a  
3 female luer lock 4 which engages with the male luer  
4 lock 4' on the device. Once the sample is taken up  
5 into device 1, puncturing means 5 may be removed and  
6 disposed of for safety, to avoid the accidental  
7 puncturing of the operator etc.

8  
9 Figure 8 shows in more detail a perspective cross  
10 sectional view of the device of Figure 7 and includes a  
11 non-return valve 23 located within housing 12 to  
12 prevent the inadvertent expulsion of the sample, for  
13 example by depressing syringe plunger 13. In the  
14 embodiment illustrated the syringe 15 is removable so  
15 that device 1 can be analysed without the continued  
16 presence of the syringe. Optionally a non-return valve  
17 may be located at both ends of the device to prevent  
18 leakage of the fluid sample.

19  
20 Figure 9 illustrates alternative optional attachments  
21 to device 1. Figure 9a is a biopsy needle and Figure  
22 9b is a small bore needle. Both puncture means  
23 illustrated in Figures 9a and 9b are provided with a  
24 female luer lock 4 adapted to engage with the male luer  
25 lock 4' present on device 1. As an alternative to the  
26 puncture means 5, it is possible to provide a soft tip  
27 fluid collection tube as illustrated in Figure 9c.  
28 Again, the female luer lock 4 is adapted to engage with  
29 the male luer lock 4' of device 1 in Figure 8. The  
30 soft tip fluid collection tube of Figure 9c may be used  
31 to facilitate collection of fluids in locations where  
32 the close proximity of device 1 may be difficult, for  
33 example to collect tear fluid from the eye etc.

34  
35 In both Figures 7 and 8 the filtration means and  
36 sensing means rely upon adhesive plugs to maintain

1     their positions within housing 12. The adhesive plugs,  
2     for example formed from LCM 34 of Ablestick Ltd, form a  
3     close fit with the internal surface of the lumen of  
4     housing 12. Desirably housing 12 is of transparent  
5     material.  
6

## 1 CLAIMS

2

3 1. A device for sampling a fluid, the device having  
4 filtration means for separating components of the  
5 fluid, a conduit directing flow of the fluid  
6 through the device, and sensing means which can  
7 detect the presence of a component in the fluid.

8

9 2. A device as claimed in Claim 1 wherein the sensing  
10 means is located to detect the presence of said  
11 component in the filtered sample.

12

13 3. A device as claimed in either one of Claim 1 and 2  
14 wherein the conduit is formed from a hollow fibre  
15 membrane which is also the filtration means.

16

17 4. A device as claimed in either one of Claims 1 and  
18 2 wherein the filtration means comprises hollow  
19 fibre membrane(s) held in a plug of cured  
20 adhesive.

21

22 5. A device as claimed in any one of Claim 1 to 4  
23 wherein the sensing means is presented on a  
24 surface of a hollow fibre membrane.

25

26 6. A device as claimed in any one of Claim 1 to 5  
27 having a puncture means.

28

29 7. A device as claimed in Claim 6 wherein said  
30 puncture means is a hypodermic, biopsy or small  
31 bore needle.

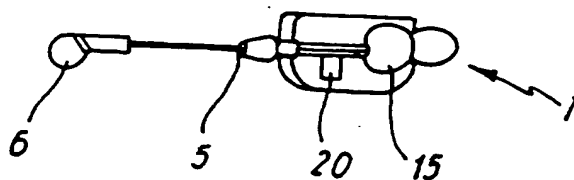
32

33 8. A device as claimed in any one of Claims 1 to 7  
34 having a pressure means.

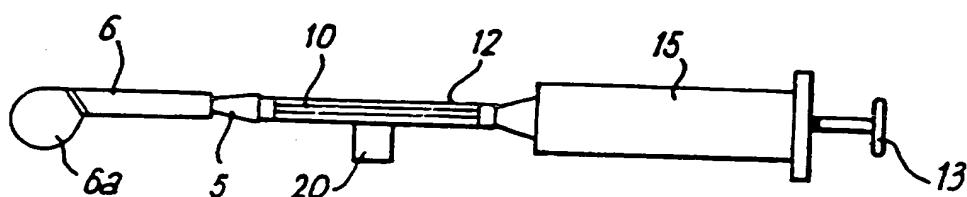
35

36 9. A device as claimed in Claim 8 wherein said

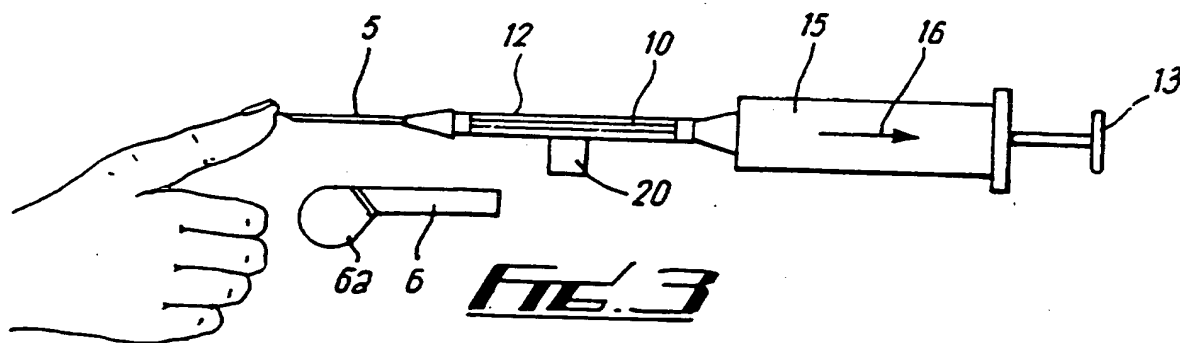
- 1           pressure means is a syringe.
- 2
- 3       10.   A device as claimed in any one of Claims 1 to 6
- 4           having a non-return valve.



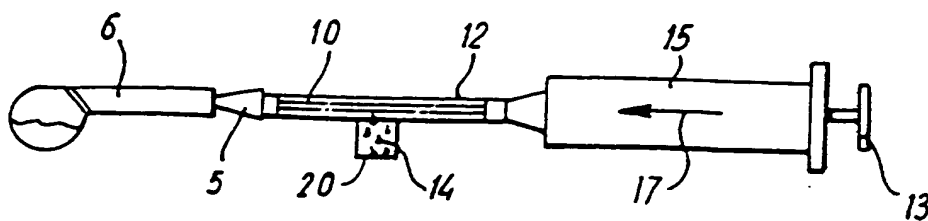
**FIG. 1**



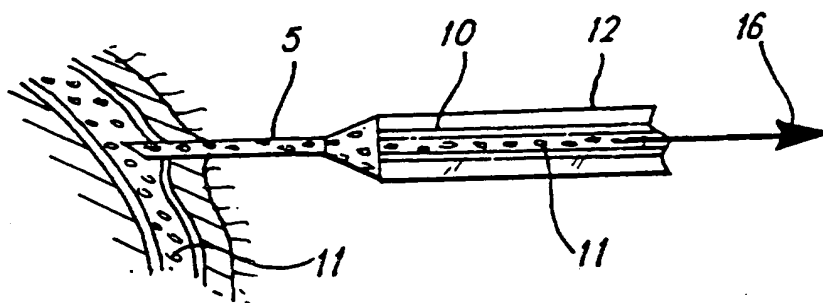
**FIG. 2**



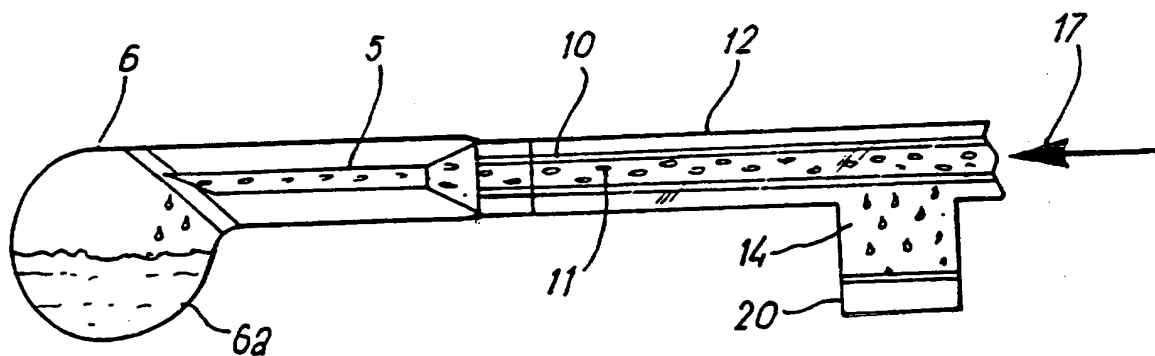
**FIG. 3**



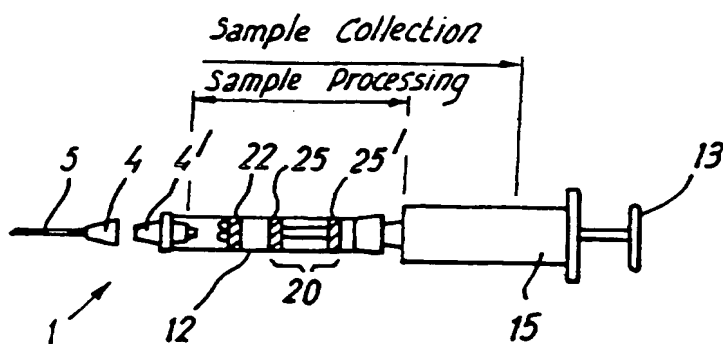
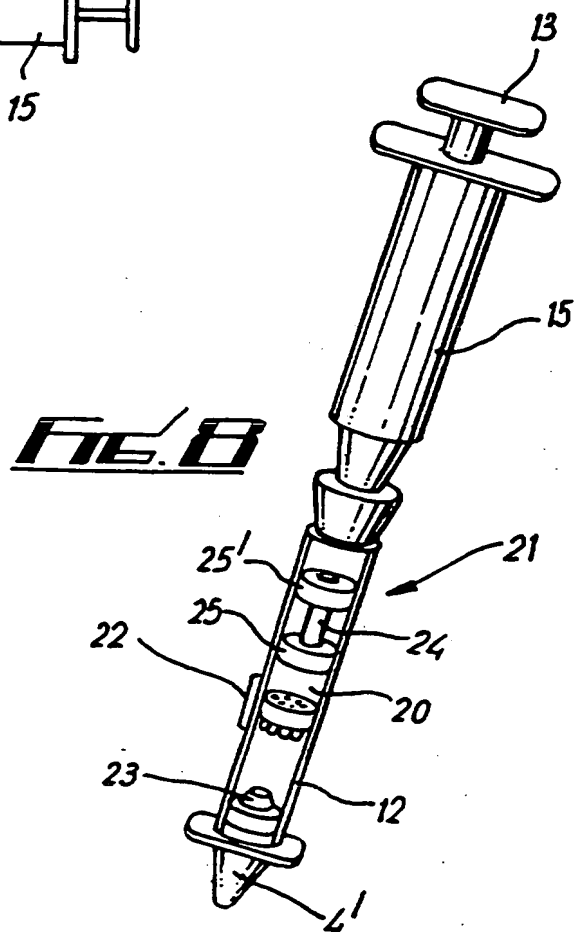
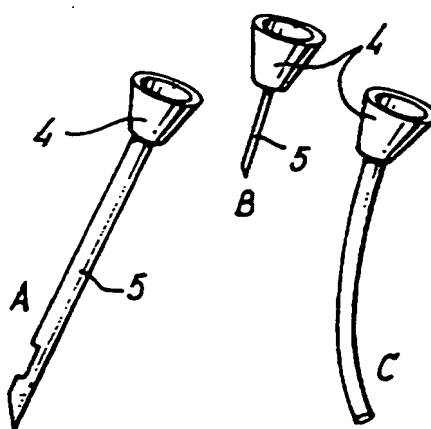
**FIG. 4**



**FIG. 5**



**FIG. 6**

**FIG. 7****FIG. 8****FIG. 9**

# INTERNATIONAL SEARCH REPORT

Int'l. Application No.  
PCT/GB 95/03031

A. CLASSIFICATION OF SUBJECT MATTER  
IPC 6 G01N33/49 G01N1/14

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
IPC 6 G01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP,A,0 549 341 (GRACE W R & CO) 30 June 1993	1-4
Y	see column 3, line 25 - column 7, line 3	6-9
A	---	5
Y	EP,A,0 550 950 (SANWA KAGAKU KENKYUSHO CO) 14 July 1993 see abstract; figures	6-9
X	WO,A,91 08782 (PROVIVO AB) 27 June 1991 see page 8, line 7 - page 9, line 37 see page 11, line 33 - page 12, line 20	1-4,6-8, 10
A	DE,A,41 32 480 (KABE LABORTECHNIK GMBH) 8 April 1993 see abstract	8-10
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	-/-	

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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- \* "&" document member of the same patent family

Date of the actual completion of the international search

11 April 1996

Date of mailing of the international search report

26. 04. 96

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# INTERNATIONAL SEARCH REPORT

International Application No  
PCT/GB 95/03031

## C(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US,A,3 848 580 (HYDEN V ET AL) 19 November 1974 see column 5, line 64 - column 6, line 57; figures 1,2	1,2,8
A	--- EP,A,0 315 252 (AKZO NV) 10 May 1989 see column 3, line 30 - column 4, line 42 -----	1-3

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No.

PCT/GB 95/03031

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A-0549341	30-06-93	NONE	
EP-A-0550950	14-07-93	JP-A- 5188053 US-A- 5364533	27-07-93 15-11-94
WO-A-9108782	27-06-91	SE-B- 465355 AU-B- 6955391 SE-A- 8904133	02-09-91 18-07-91 08-06-91
DE-A-4132480	08-04-93	NONE	
US-A-3848580	19-11-74	SE-B- 383258 AT-B- 353396 AU-B- 466549 AU-B- 3655871 CA-A- 957922 CH-A- 536116 DE-A- 2160217 FR-A- 2117471 GB-A- 1347379	08-03-76 12-11-79 30-10-75 14-06-73 19-11-74 30-04-73 13-07-72 21-07-72 27-02-74
EP-A-0315252	10-05-89	CA-A- 1320142 DE-D- 3852375 DE-T- 3852375 ES-T- 2065332 JP-A- 1151909 US-A- 4995967	13-07-93 19-01-95 24-05-95 16-02-95 14-06-89 26-02-91